APPENDIX R - Structural Survey Assessment Report

Comrie and Dalginross

2013 Flood Study

Flood Defence Inspection Report

03 November 2014 – Issue 2

Produced for
Perth and Kinross Council

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Existing Structure Location Plan

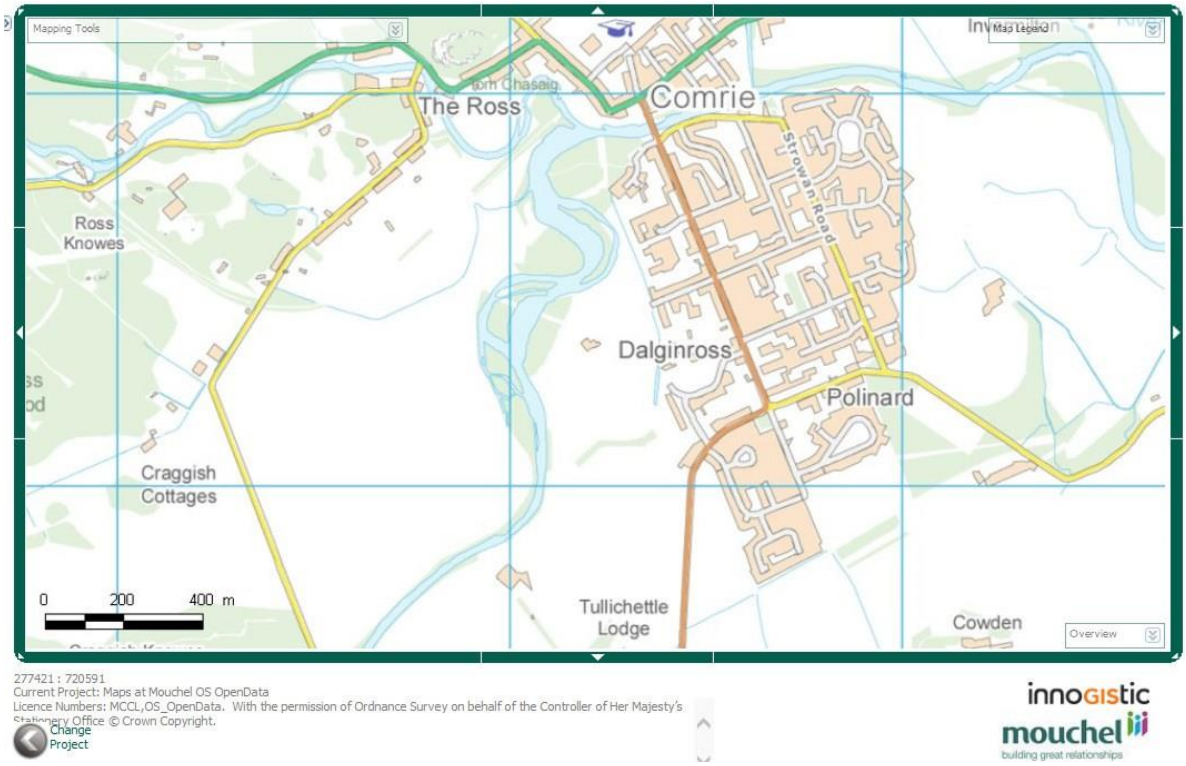


Figure 1 - Location Plan

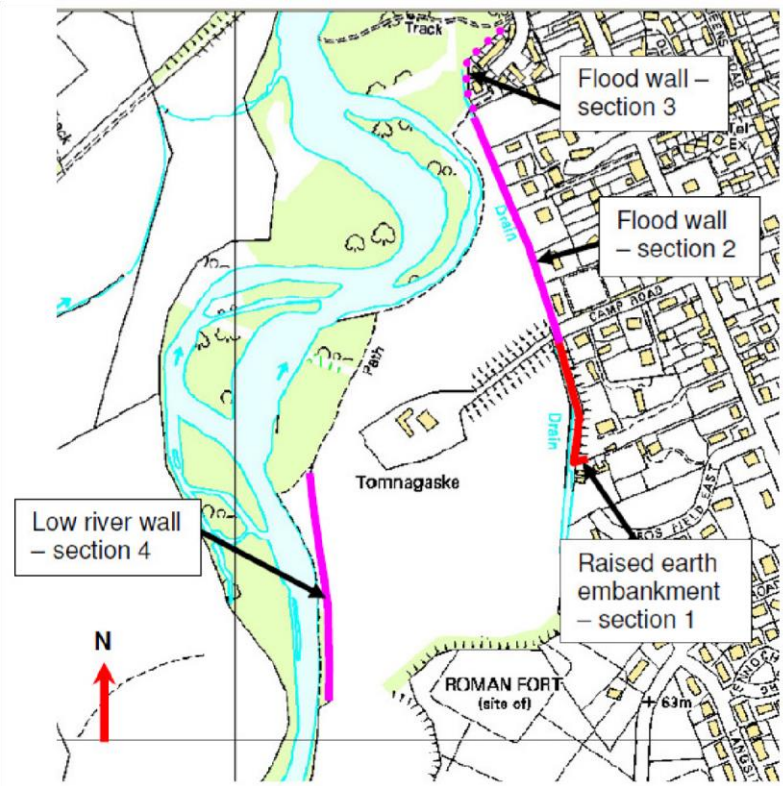


Figure 2 – Structure location plan

1.0 Executive Summary

As part of the Comrie & Dalginross Flood Study, Mouchel were briefed to undertake a structural inspection of the flood defences which lie to the west of the town and run in a generally north-south direction. The survey took place on 31st October 2013.

The earth embankment and structures inspected in section 3.1, 3.2, 3.3 and 3.4 of this report were found to be in reasonable condition.

The earth embankment is well vegetated and generally in good condition. The top surface of the embankment is being used as a footpath. Erosion of this top surface and sections of the eastern face caused by pedestrian movement have resulted in an uneven crest and potential reduction in the standard of flood protection. Measures are required to repair these uneven areas and prevent future pedestrian use.

Some sections of the masonry wall stems exhibit areas of mortar loss to the joints and therefore minor repointing is advisable.

The mass concrete walls are generally in good condition although they appear to have been built with simple construction joints at approximately 15 metre intervals. Cracks at these construction joints are probably due to early thermal movements when concrete was poured and are not of immediate concern. Spalling of concrete was noted at the construction joint cracks and minor concrete repair to these sections is recommended.

At isolated locations there are substantial trees immediately adjacent to the walls. Although the trees are not significantly affecting the wall at present, their close proximity indicate a potential for future damage from the root systems. These locations should be monitored regularly.

The general condition of the flood defences has not deteriorated significantly since the last inspection in 2011. It is recommended that all remedial works highlighted in this report are carried out within the 12 months of this report being issued and at a minimum prior to the next scheduled Principal Inspection. It is also recommended that they are inspected at intervals not more than five years and after severe flooding events. A general de-vegetation of the Fey Burn is also recommended.

2.0 Introduction

As part of the Comrie & Dalginross Flood Study, Mouchel were commissioned to undertake a structural inspection of the town's flood defences. For this particular aspect of the Flood Study, Mouchel's Flooding & Drainage Division issued an internal brief, dated 28 October 2013, to the Infrastructure Services Division's Glasgow Office.

The flood defences are split into four sections as shown in the structure location plan and are described below.

Section 1 consists of a raised earthwork embankment;

Section 2 consists of a wall with a substantial mass concrete base and either a mass concrete or natural stone masonry stem;

Section 3 consists of a wall which is also constructed from mass concrete but is smaller in cross-section and appears to be of more recent construction to that in section 2 (Note – this section of flood wall is not under the ownership of Perth and Kinross Council);

Section 4 consists of a low mass concrete river wall.

The previous information provided by PKC prior to the inspection included the following –

- A drawing dated 16 March 2011 showing the extent of the Flood Defences to be inspected.
- Three record drawings, C1, C2 & C3 dated June 1960 showing details of the earthworks forming the southern section of the defence structure and strengthening and raising works undertaken to a 222 metre section of the existing concrete/masonry wall north of Camp Road.
- A previous Flood Defence Inspection Report dated 31 March 2011.

The brief required that the defences be inspected and any issues likely to affect its function as a flood defence noted. Recommendations on repair works have also been included. Note – the inspection did not involve any intrusive techniques.

The inspection was carried out on 31 October 2013. The weather was dry in the morning and started raining in the afternoon. Chainages referred to in this report (Appendix A) are measured from the southern end of the structures.

3.0 Inspection

3.1 Section 1 – Raised Earth Embankment

3.1.1 Chainage 0.0 to 167 metres – earth embankment

Approximately 167 metres of the earth embankment runs parallel to the Fey Burn and approximately 20.4 metres of embankment runs on the south side along the Camp Road toward Tomnagaske House (photograph 2) The earth embankment is approximately 1.5 metres in height above the adjacent land

on its west side (photograph 1). The Fey Burn runs in a ditch immediately to the west of the embankment.
The earth embankment is generally in good condition with no signs of slip or scour. The embankment is generally well vegetated. The crest of the embankment is not level as it is being used as a footpath from approximate chainage 39 metres onwards to the north. Manmade steps were seen at chainage 39 metres on the east side, leading to minor erosion where the embankment changes direction (photo 2). There was no evidence of burrowing animals inhabiting the embankment. Other photographs; photo 6 looking west and photo 7 looking east along the embankment.

3.1.2 Reinforced concrete pipe culvert

A reinforced concrete pipe conveys the Fey Burn under Camp Road. A CCTV survey was not undertaken and only the culvert Inlet & Outlet were inspected. It was noted that the flap valve referred to in record drawings is no longer present (Photograph 4). The culvert appears to be in good condition (Photograph 5).

3.2 Section 2 – PKC Flood Wall

3.2.1 Chainage 0 to 48 metres – concrete base with masonry stem

Referring to record drawing C1, (refer to Appendix C) this section of wall appears not to have been raised or strengthened by the works undertaken circa 1960 (Photograph 8), but is very similar in construction and is probably contemporaneous. The following notes were taken during the inspection.

- A steel pipe (Photograph 9) runs through the mass concrete base at approximate Chainage 9.8 metres measured from the start of the wall. The pipe runs across the Fey Burn. The pipe is buried to the west side and is cast in concrete on the east side;
- Mortar loss was noted at Chainage 19.6 metres which should be repointed (Photograph 10);

3.2.2 Chainage 48 to 116 metres – concrete base with concrete/ masonry stem

This section of wall appears to have been raised by the works undertaken circa 1960. The key inspection comments are as follows:

- Photographs 11 and 12 show localised rust stains and a crack in the wall at chainage 81.3 metres. Photograph 13 shows an area at the top of wall with 3 legged cracks. This section of wall was noted to have a hollow sound around a previously repaired concrete section. This is not considered to be of immediate concern but should be monitored during future inspections.
- Photograph 14 shows localised bulging in the wall and loose masonry. This does not however, look to be of immediate concern. Repointing and monitoring this section of wall is highly recommended. A crack in the wall that continues down to the mass concrete was seen at chainage 111 metres, refer photograph 15. A tree was noted directly

behind the wall at this point. It is suggested that the tree roots might be inducing pressure on the wall at this point.

3.2.3 Chainage 116 to 267 metres – concrete base with concrete / masonry stem

A review of as-built information shows that this section of wall has been raised and strengthened by works carried out circa 1960. The wall construction now consists of an apron wall below ground and in front of the old masonry / concrete wall. The apron wall has a layer of mesh anti-cracking reinforcement in the front face. A mass concrete sloping face and stem wall have then been cast above this apron wall to strengthen and raise the original concrete/masonry stem behind. Vertical construction joints are located at 15.2m intervals.

The wall is generally in good condition with no movement or distortion evident, although some minor defects were noted –

- There is cracking at the vertical construction joints. There is no flexible filler detailed at the joints and the cracking is likely to have occurred soon after construction as a result of early thermal shrinkage of the concrete (photograph 15). However, the cracking is generally superficial and is not of concern;
- There is vertical cracking on the wall and localised spalling around the cracking (photograph 15). Again early thermal movement is the likely cause. It is recommended that this is repaired using a crack repaired pripr to the next inspection;
- The concrete surface on the sloping face and the lower section of the wall is extensively covered with moss. This section of the wall could therefore not be inspected (photograph 16 looking south on wall and photo 17 looking north on wall). Removal of vegetation is recommended prior to future inspections;
- A crack in the wall that continues through the mass concrete was seen at chainage 141.8 metres. A tree is located behind the wall where the crack appears (photograph 18). The tree at this point was not touching the wall but the roots might be the cause of the crack. There is no immediate concern but it is recommended that this is monitored during future inspections with a view to removing the tree if required;
- At chainage 170 all three sections of the wall are cracked and there is evidence of vegetation growth within the cracks (photograph 19).

  Vegetation should be removed and cracks repaired prior to the next inspection;
- Photograph 20 shows the crack in the base of concrete wall at chainage 184.7 metres. This is not believed to be significant, however its is recommended that this is repaired prior to the next inspection;
- Spalling of concrete has occurred at the crack shown in photograph 21;

- Hairline cracks were noted at chainage 204 metres. There were 4 vertical cracks at 4 metre intervals. There is a tree house behind the wall (photograph 22) These are not thought to be significant but should be monitored for movement at the next inspection;
- Photograph 23 shows a crack on the surface at chainage 225 metres which is not of immediate concern. Recommend monitoring for movement at the next inspection;
- At chainage 231 metres, calcite deposits on the concrete base were noted indicating the surface of the concrete to be damp. The freezing and thawing can cause the concrete to crack and crumble reducing the cover to reinforcement (photograph 24);
- Calcite deposits with multiple cracks on concrete base at chainage 255 metres (photograph 25). The cracks should be repaired and monitored at the next inspection;
- Mapping cracks were seen on the sloping section of the wall at chainage 259.5 metres (photograph 26). Map cracking can be a symptom of alkali – silica reaction within the concrete. Not of immediate concern but needs to be inspected during planned inspections;
- The metal ladder at the north end of this section is in a poor condition and should be replaced. (photograph 27);
- There is vegetation growth along the whole length of flood wall. It is recommended that his is removed prior to the next inspection;
- It was also noted that at a number of locations, the local residents had attached fence supports to the flood wall; photograph 28 shows an example.

3.3 Section 3 – Private Flood Wall

3.3.1 Chainage 0 to 128 metres – concrete wall

Section 3 chainage starts from the staircase at the end of section 2. This section of wall appears to be mass concrete and is around 0.5 metres high. It appears to have been raised recently (photograph 29), presumably to provide enhanced protection to the housing development adjacent to the east of the wall.

The wall is generally in good condition with no signs of movement or distortion. However, some minor cracking was noted (photographs 29 and 30). In some areas, the recent addition to the wall shows signs of honeycombing and spalling on the vertical faces where new concrete has been cast above the existing concrete. This would indicate poor workmanship during construction but is not of immediate concern. (Photograph 30).

3.4 Section 4 – Low River Wall

3.4.1 Chainage 0 to 267 metres – concrete wall

Section 4 chainage starts from south end of the wall. No drawings or previous information was available at the time of this inspection. The wall is 230 mm thick and approximately 0.45 metres in height above the adjacent ground at the southern end, but is almost buried at the north end. Moss has grown on the full length of the wall.

- Photograph 31 shows a general photo of the wall at south end;
- Photograph 32 is at chainage 8.2 metres. The tree next to the wall is suspected to have caused the crack;
- At chainage 8.2 metres looking north, the wall appears to lean outwards (Photograph 33);
- Trees are situated very close to the wall which may be causing the wall to crack. Reinforcement was not visible through the open crack at chainage 14 metres (Photograph 34);
- Photograph 35 also shows trees close to the wall;
- There is heavy vegetation growth around the wall with the majority of the surface covered in moss;
- The section of wall between chainage 237 metres and 264 metres is buried and cannot be seen;
- The wall appears to terminate at chainage 267 metres (Photograph 36).

Post Inspection Comment

Despite the wall being in poor condition this is not thought to cause any issues with regard to the properties of Dalginross as flood protection is provided by sections 1, 2 & 3.

4.0 Conclusions and Recommendations

The flood defence walls & embankments are generally in good condition with no immediate cause for concern. The key conclusions and recommendations are as follows:

Section 1

The earth embankment is generally in good condition. However, it is recommended that if possible, some action is taken to prevent pedestrians using the embankment as a footpath. This would minimise erosion of the embankment and ensure the embankment crest remains level and provides the same standard of protection along its length. The installation of geo-textile would prevent further erosion if necessary.

** *Post Inspection Note:* The pedestrian access to the top of the embankment has now been partially restricted by a timber fence constructed at the North end of the embankment.

Section 2

The condition of the wall in this location has not changed significantly since the last inspection in 2011. Mortar loss is evident on some sections of the masonry wall stem and although not of immediate concern to the flood walls functionality, some re-pointing is advisable to ensure its long term integrity. Repointing works are estimated to be in the region of $15m^2$. There are also some repair works required at the construction joints where minor cracking is evident. Flexible filler is recommended to seal the construction joints. Minor concrete repairs are also recommended for cracks in other areas.
A cost estimate for carrying out these works is difficult to provide at this stage due to access issues and uncertainty caused by areas covered with vegetation. However, a rate of around £60 to £100 per m^2 would not be unreasonable. It is recommended that all vegetation growing within the wall is removed. Small areas of rust staining are evident along the horizontal joint in the concrete base. This is believed to be a result of corrosion of the anti-cracking reinforcement in the base. As no spalling or cracking is evident no major repairs are required.
A number of trees were noted directly behind the wall co-incident with cracking. These cracks should be repaired and monitored for further movement at future inspections. Trees should be removed and roots killed if movement is noted. A general de-vegetation of Fey Burn is also recommended. The defects described above should not affect the overall function of this wall but should be monitored during future inspections.

Section 3

The visible section of the concrete wall appears to be in generally good condition. The new section of wall constructed on top of the old concrete wall appears to be in sound condition. Minor cracks are present but these are not of immediate concern.

Section 4

This wall appears to be in poor condition with cracks mainly in locations where trees have grown in close proximity. However this wall is not part of the flood protection and therefore no remedial actions are required at this stage.

It is recommended that the flood defences are inspected at intervals not more than five years and after severe flooding events.

5.0 Estimated Residual Life Span

Mouchel have been asked to comment on the residual life span and potential for incorporating each section of flood defence in any future flood protection schemes. The comments / advice given below are based on a qualitative assessment of the existing condition of the structures following the visual inspection carried out in October 2013. An estimate of the residual life of these structures is given based on these findings. Further testing may provide information such as material strengths which could be used in a quantative assessment to identify load capacity of the structures. The requirement for further testing was outside Mouchels brief for this inspection, however, as there are no significant areas of material degradation, taking samples and testing is unlikely to provide any further significant information.

Section 1 – It is assumed from the as built information provided in Appendix C that this earth embankment was constructed circa 1960. The embankment was found to be in good condition with recommendations given in section 4 of this report, to minimise future erosion of the crest. If the remedial works are undertaken to this end, then given there are no obvious visual signs of instability to the embankment foundation, it would be reasonable to assume this embankment could remain in service for a period similar to its current lifespan i.e. approximately 50 years. This assumes that flood conditions remain similar to those experienced throughout the structures current service life. Should future flooding levels or frequencies increase a further assessment would be required. However it is assumed that a small rise in flood levels could easily be accommodated by raising the height of the embankment if required.

Section 2 – This section of wall was strengthened and raised circa 1960 as referred to in section 1 and Appendix C. It is currently in reasonable condition with a number of minor defects and areas of remedial works which require attention. There are no obvious signs of instability to the structure and no signs of scour to the substantial concrete foundation. However given the degree of vegetation growing in close vicinity of the structure it would be prudent to assume regular maintenance inspections will be required. This may have an influence on the residual life span of the structure and will be dependent on the frequency of on-going maintenance. It is therefore difficult to assess the residual life span of this section of flood defence. However if the current defects and remedial works are addressed and a regular maintenance programme is put in place to manage the vegetation close to the wall it would be reasonable to assume this structure could remain in service for a further 40 – 50 years. As previously discussed this assumes that flood conditions remain similar to those experienced throughout the structures current service life. Should future flooding levels or frequencies increase a further assessment would be required. This would include stability calculation checks etc. once any height increase was established. However it is assumed that a small rise in flood levels could easily be accommodated by raising the height of the vertical concrete facing in front of and above the masonry wall. It should be noted that any proposed increase in height to this wall would cause some level of disruption to the properties it protects as boundary fences & hedges would likely need to be removed.

Section 3 – No as-built information was provided for this section of flood defence but due to its form of construction it is assumed to be quite recent. The wall is generally in very good condition with minor defects. Given its current condition and assumption that flooding conditions remain similar to previous years it would be reasonable to assume this section of structure would have a similar or better residual service life to that of sections 1 and 2 i.e. approximately 50 years or greater. As with the previous sections, a further assessment would be required if the frequency or level of flooding was to increase. However given the geometry of this thick mass concrete wall a small increase in flood level could easily be achieved without affecting the stability of the structure. This however, should be checked by calculation once any increase in flood levels was established. It should also be noted that the wall forms a boundary to a number of residential properties which have boundary fences and hedges built above or adjacent to the wall. A proposed increase in height to this wall could therefore cause some level of disruption to these properties.

Section 4 – As indicated in the conclusions and recommendations this section of wall is in poor condition with a number of cracks caused by trees growing very close to the wall. However as this does not form part of the flood defence and has little impact on the surrounding area, it has not been considered further.

Appendix A – Photographic Plates

Appendix A – Photographic Plates

Photograph 1 – Earth bund looking north

Photograph 2 – Localised bank erosion where bund changes direction

Photograph 3

Photograph 4 – North end of the pipe (no flap valve)

Photograph 5 – South end of the pipe

Photograph 6 – looking west towards Tomnagaske House

Photograph 7 – Looking East on Earth bund

Photograph 8 – Concrete base with concrete/masonry stem

Photograph 9

Photograph 10

Photograph 11 – rust stains.

Photograph 12

Photograph 13

Photograph 14

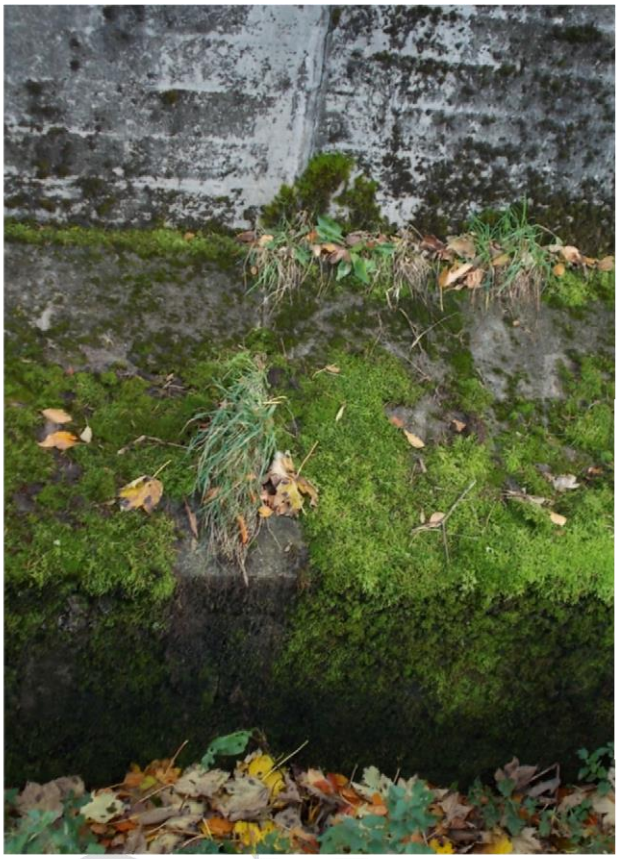
Photograph 14(a)

Photograph 15

Photograph 16 looking South

Photograph 17 looking North

Photograph 18



Photograph 19 wall cracked from top of wall to invert level

Photograph 20

Photograph 21

Photograph 22

Photograph 23

Photograph 24

Photograph 25 calcite deposits and multiple cracks on base of concrete.

Photograph 26

Photograph 27

Photograph 28

Photograph 29

Photograph 30

Photograph 31

Photograph 32

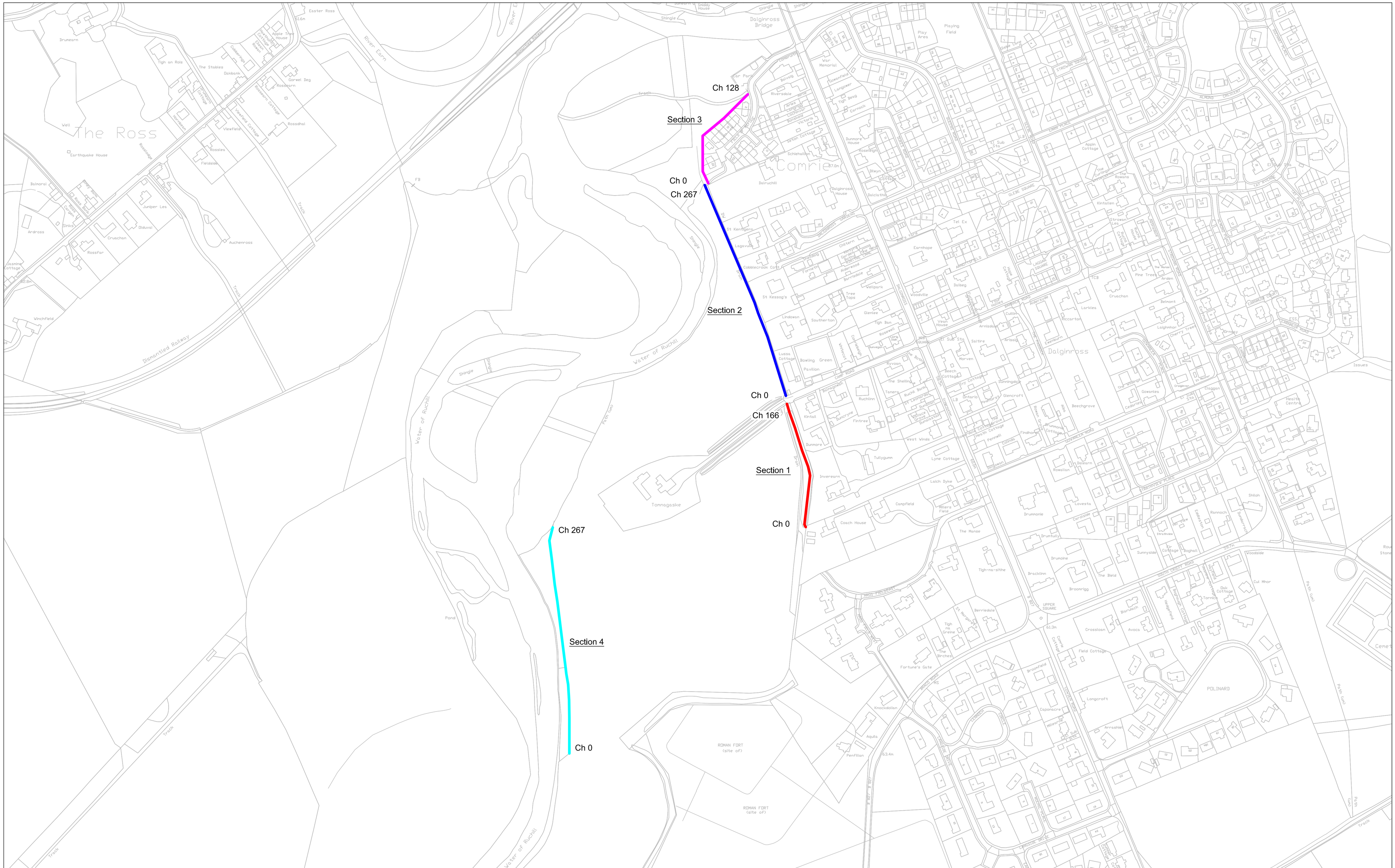
Photograph 33

Photograph 34

Photograph 35

Photograph 36

Appendix B – Existing Flood Defence Location Plan



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							DATE: - DATE: July 2014
							DRAWN BY: GOH APPROVED BY: MT
		REV	REVISIONS	BY	CHKD	APP'D	DATE: July 2014 DATE: July 2014
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ENGINEER	DRAWING TITLE		
mouchel building great relationships	Existing Flood Defences Location Location & Chainages		
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APPENDIX C - As Builts

SECTION : AA

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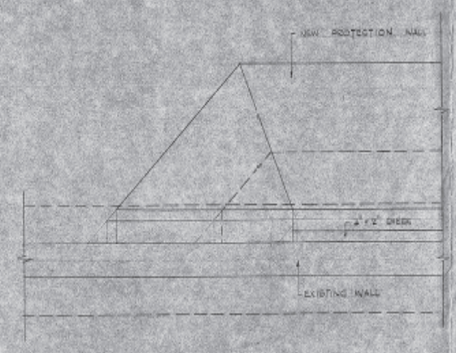
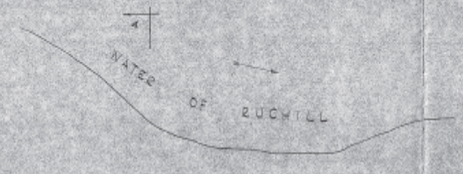


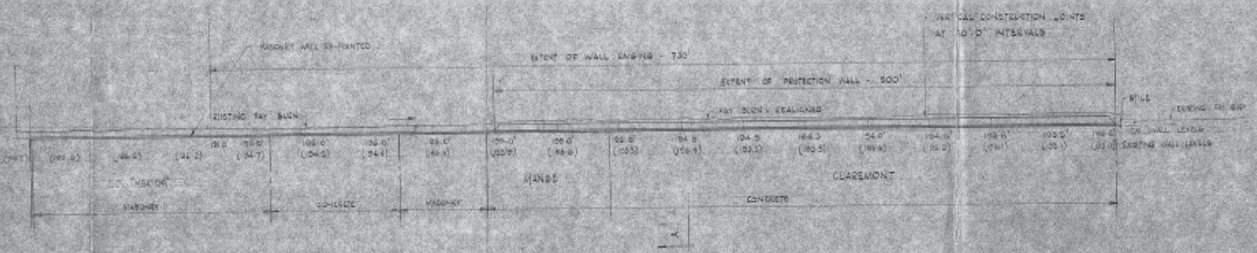
DETAIL OF END OF PROTECTION WALL

SCALE : ¾" = 1'-0"

KEY PLAN

SCALE : 1/1500





PLAN

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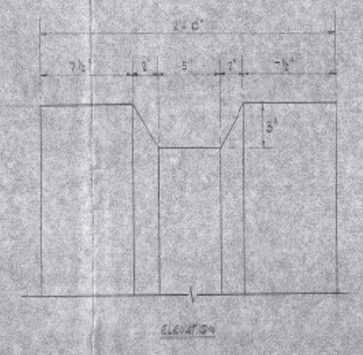

ELEVATION

PLAN

DETAILS OF HORIZONTAL AND VERTICAL CONSTRUCTION JOINTS

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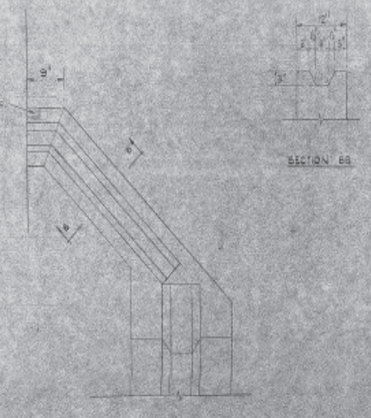

SECTION BB

DETAILS OF CONSTRUCTION JOINT ON SLOPING WALL

SCALE : 1" = 1'-0"

NOTES:

1. THIS DRAWING TO BE READ IN CONJUNCTION WITH BEC NOS. 1/2-4 & 6/4
2. ALL CONCRETE TO BE 7/14 QUALITY

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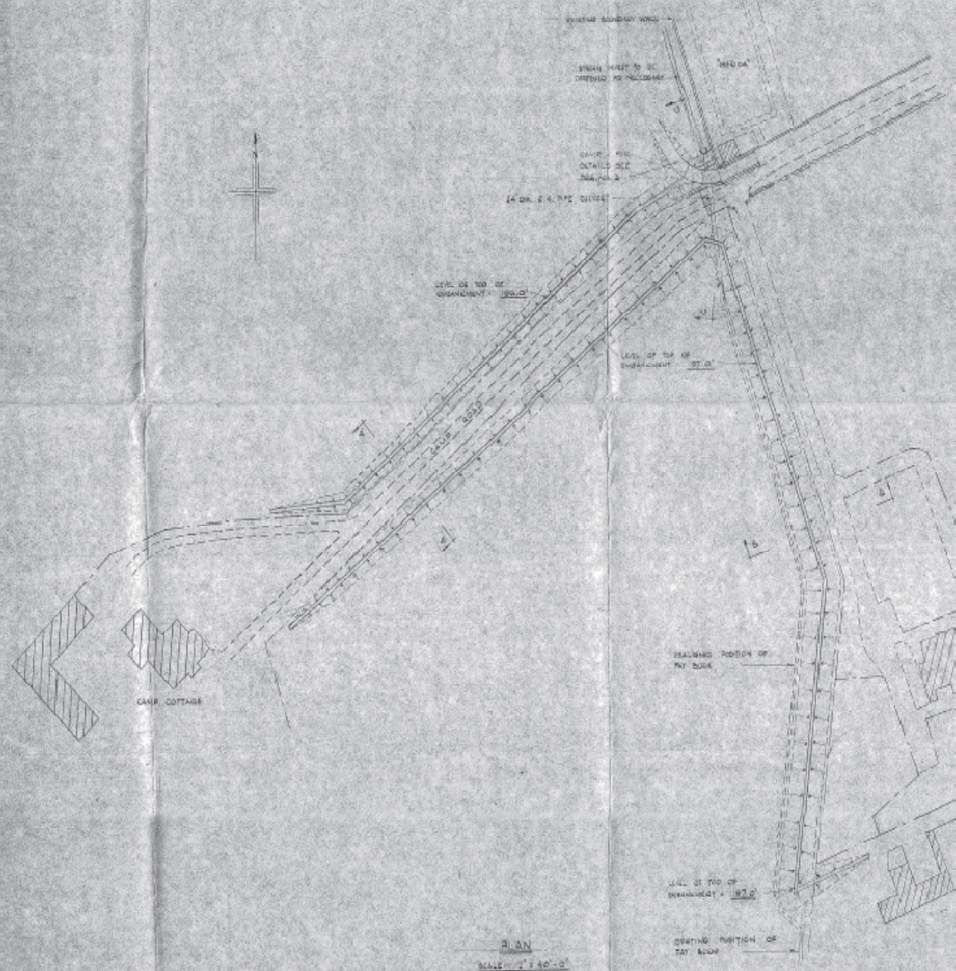
EXISTING FLOOD WALL DETAILS OF STRENGTHENING AND RAISING	SCALES: 1" = 10'-0", 1" = 1'-0", 3" = 1'-0" DRAWN D.C. DATE APRIL 1966
MAY 1966 REVISED TO SHOW DETAILS AS BUILT	

PARTS, BLOW & MORTON, B.C.E. 17, BOTHWELL SQUARE, GLASGOW C.2

WSP/22/43/1

Tech 1836



PLAN
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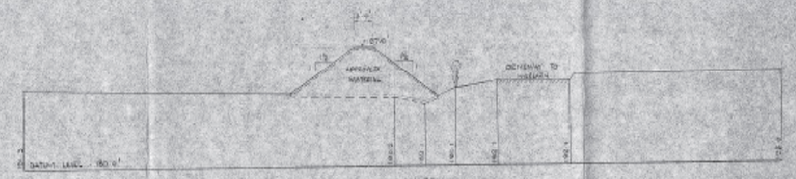
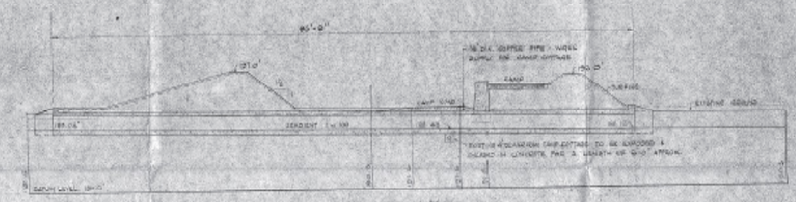
SECTION A-A



SECTION B-B



SECTION C-C

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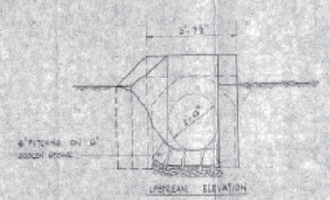
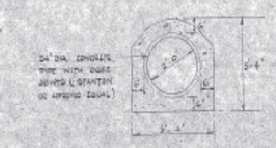
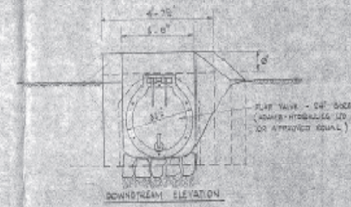
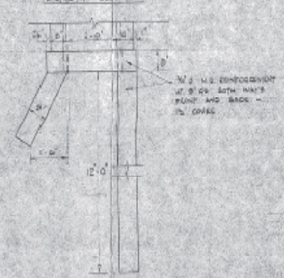








PLAN

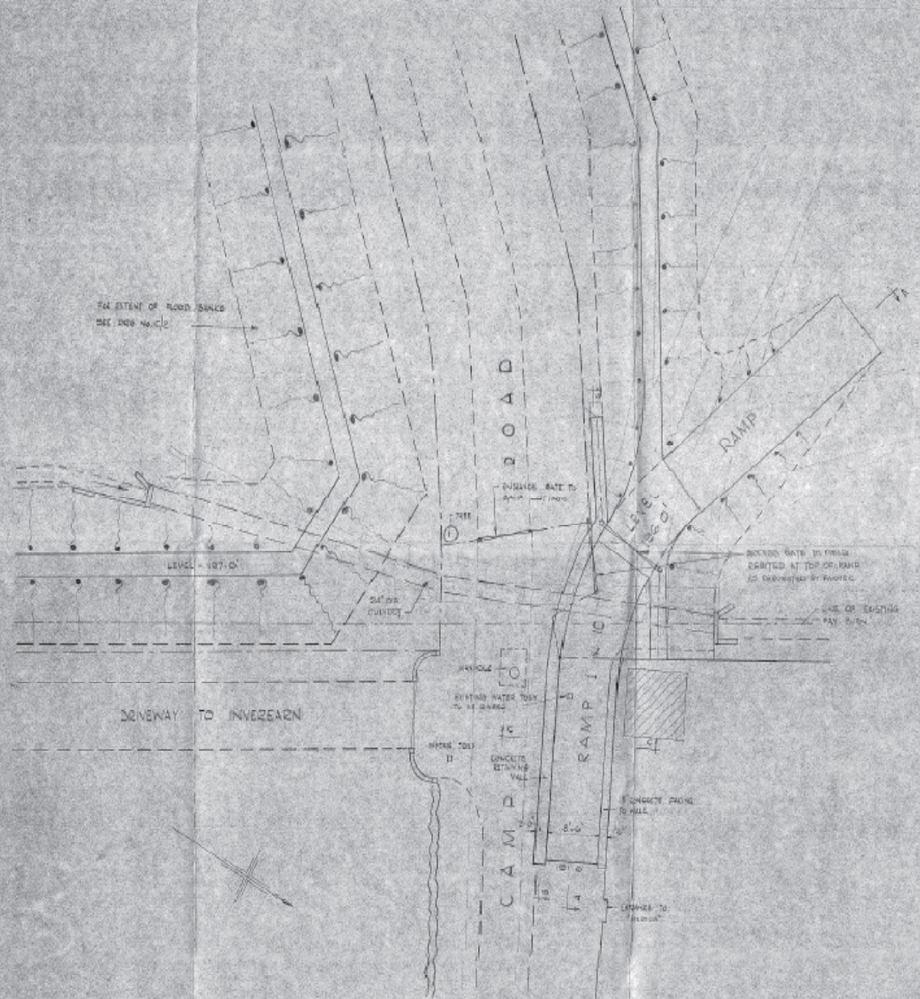
DETAILS OF CULVERT

SCALE = ¾" = 1'-0"

NOTES:
1. THIS DRAWING TO BE READ IN CONJUNCTION WITH DOC No's C/C & C/R
2. ALL CONCRETE TO BE 3/4" AGGREGATE
3. ALL BEVELLED EDGES TO BE PROVIDED WITH ¾" CHAMFERS

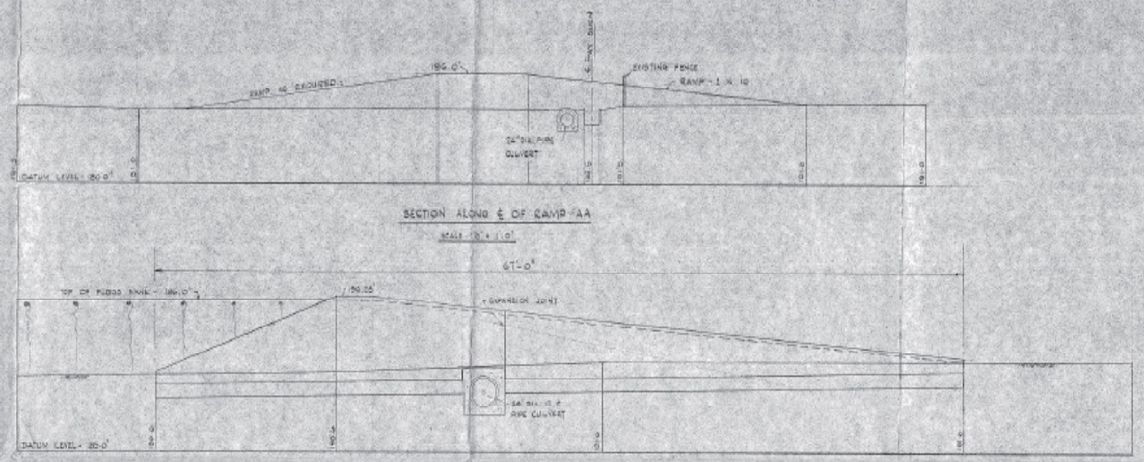
PERTH COUNTY COUNCIL WORKS OF ROYAL - CANADA	JOB No. 0679 DOC No. C/C REF No. 122903
FLOOD PROTECTION DETAILS OF FLOOD BANKS AND 24" DIAMETER CULVERT	SCALES 1" = 40'-0" ¾" = 1'-0" ½" = 1'-0" DRAWN DC / APPROVED D.D.F DATE JUNE 1960
FAY 1365 REVISED TO SHOW DETAILS AS BUILT	MAPLE, SWAN & WORTH, C.E. ST. MATHIAS BARRIE, ONTARIO

WSP/22/43/2



PLAN OF RAMP AND CULVERT

SCALE - 1/8" = 1'-0"

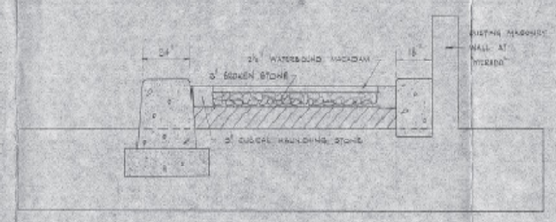


SECTION ALONG ℄ OF RAMP AA

SCALE - 1/8" = 1'-0"

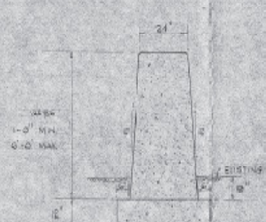
LONGITUDINAL SECTION OF RETAINING WALL-BB

SCALE - 1/8" = 1'-0"



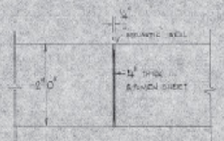
SECTION CC

SCALE - 1/8" = 1'-0"



CROSS SECTION OF RETAINING WALL

SCALE - 1/2" = 1'-0"



DETAIL OF EXPANSION JOINT

SCALE - 1/2" = 1'-0"

NOTES

1 — THIS DRAWING TO BE READ IN CONJUNCTION WITH DRG Nos. C/1 & C/2.

2 — ALL CONCRETE TO BE 21 N/mm² QUALITY.

3 — ALL EXPOSED ARISES TO BE ROUNDED WITH ¾" CHAMFERS.

NORTH COUNTY COUNCIL WATER OF RUCHILL - COMRIE	JOB NO. 1998/46 DRG No. C/3 REF. No. 1998/D
FLOOD PROTECTION DETAILS OF FARM ACCESS RAMP	SCALES 1/8" = 1'-0" 1/2" = 1'-0" 1/4" = 1'-0" DRAWN D.C. APPROVED D.C.F. DATE: JUNE 1998
MAY 1999 DESIGNED TO SHOW DETAILS AS BUILT	ALBERT, MANN & WATSON DES. J. BATTEN DRD. ROYALE INVERSEARN

WSP/22/43/3